Claims

1. Method for information storage and data processing comprising the step of thermo inducing or photo inducing double-bond shifts (DBS) in substituted [4n]-annulenes, thus generating transitions between two different conjugation states with at least one substituent.

2. Method according to claim 1, whereby the two different conjugation states are the conjugation on-state and conjugation off-state of the annulene core π-electrons relative to the substituent π-electrons.

3. Method according to claim 1 ~~or 2,~~ whereby said [4n]-annulenes are bicyclic [4n]-annulenes.

4. Method according to claim 3, whereby said bicyclic [4n]-annulenes are heptalenes.

~~5. Method according to any of the claims 1 to 4, whereby the [4n]-annulenes~~ which are substituted by at least one group comprising an extended conjugated π-electron system which is in conjugation with the π-electron system of the [4n]-annulene core.

~~6.~~ Method according to claim ~~5,~~ whereby the [4n]-annulenes are substituted in 1,2- or 1,4-position relative to each other by two groups having an extended and conjugated π-electron system.

~~7.~~ Method according to ~~any of the preceeding claims,~~ whereby a multitude of [4n]-annulene molecules are arranged in a 1-dimensional or in a 2-dimensional or in a 3-dimensional way and wherein said conjugation states are spacially non-uniformly modulated.

8. Method according to claim 7, whereby a conformationally restricted matrix system is generated by modulating said conjugation states.

9. Method according to ~~any of the preceeding~~ claims, whereby the [4n]-annulene molecules are embedded in a matrix.

10. Method according to claim 9, wherein the matrix comprises a low-melting glass or polycarbonates, polyacetates, methacrylates, styrenes and copolymers thereof, as well as copolymers with polymerisable [4n]-annulenes.

11. Method according to ~~any of the~~ claims 7 ~~to 10~~, whereby a holographic grating is generated by modulating said conjugation states.

12. Method according to ~~one of the~~ claims 7 ~~to 11~~, wherein the spacially non-uniformly modulated conjugation states are generated by a low-energy laser that provides for a local heating so bring the [4n]-annulenes into switching condition and whereby the laser light causes locally, if required, the switch from the conjugative on-state to the conjugative off-state.

13. Method according to ~~any of the~~ claims 8 ~~to 12~~, comprising further to said step of modulating a multitude of [4n]-annulene molecules in a 1-dimensional or 2-dimensional or 3-dimensional way and wherein said conjugation states are spacially non-uniformly modulated, a further step wherein at least one of the optical, electrical or magnetic properties being attributable to said switchable conjugation states is determined and processed.

13
14. Method according to any of the preceeding claims, wherein said conjugation states are determined by an optical read-out step.

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15. Method according to any of the preceeding claims, wherein the determination of the spacially non-uniformly modulated conjugation states is used for the optical reading of information.

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16. Method according to any of the preceeding claims, wherein the determination of the spacially non-uniformly modulated conjugation states is used for optical switching and computing.

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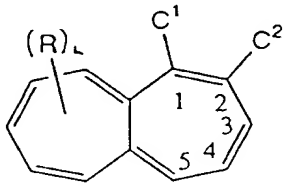
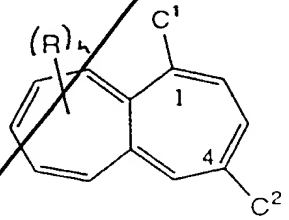
17. Substituted [4n]-heptalenes of the general formula (I) or (II) being optically and/or thermally switchable, based on thermal or photochemical double-bond shifts (DBS),



(I)



(II)

whereby C^1 and C^2 represent independently from each other a hydrogen atom, a substituted or unsubstituted C_1-C_{12}-alkyl group, a substituted or unsubstituted C_1-C_{12}-alkoxy group, a substituted or unsubstituted aryl-C_1-C_{12}-alkyl group, a substituted or unsubstituted C_1-C_{12}-alkenyl group, a substituted or unsubstituted C_1-C_{12}-conjugated alkenyl group, a substituted or unsubstituted C_1-C_{12}-alkinyl group, a substituted or an unsubstituted phenyl group, a substituted or an unsubstituted heterocyclic group, a cyano group, a nitro group, a thiocyanate group, a C_1-C_{12}-ester group being optionally polymerisable with copolymers, with the proviso that at least one of

said substituents C^1 and C^2 contains a π-electron system which is in conjugation with the π-electron system of the heptalene core, and

whereby said [4n]-heptalenes can comprise at least one further substituent R being selected from the above indicated groups with n being 0-8,

provided that if one of the at least one further substituents R is a isopropyl group at the position 9 of the heptalene ring, the substituent at the position 6 must not be a methyl group, and

with the proviso that heptalenes having the the following substituents (including their valence isomers) are excluded :

the positions 1 and 2 (or 3) are substituted by a methylester group, whereby R is H

the positions 1 and 2 (or 3) are substituted by a methylester group (or position 3 could be substituted by Azulenium) and the positions 5, 6, 8 and 10 are substituted by a methyl group,

the positions 1 and 2 (or 3) are substituted by a methylester group and the positions 4, 6, 8 and 10 are substituted by a methyl group,

the positions 1 and 2 (or 3) are substituted by a methylester group and the positions 6, 8 and 10 are substituted by a methyl group,

the positions 1 and 2 are substituted by a methylester group and the positions 5, 6 and 10 are substituted by a methyl group,

the positions 1 and 2 (or 3) are substituted by a methylester group and the position 10 is substituted by a methyl group,

the positions 1 and 2 are substituted by a methylester group, the position 5 is substituted by a styrene group, the position 7 is substituted by a isopropyl group and the position 10 is substituted by a methyl group, <1>

the positions 1 and 2 are substituted by a methylester group, the position 4 is substituted by a

<1> = the position 1 is substituted by a methylester group, the positions 2 and 5 are substituted by a $-CH=CH-CH=CH-C_6H_5-$ group, position 7 is an isopropyl- and position 10 a methyl group,

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styrene group and the positions 6, 8 and 10 are substituted by a methyl group,

the positions 1 and 2 are substituted by a methylester group, the position 5 is substituted by a styrene group or a 4-chloro styrene group or a 4-methoxy styrene group, and the positions 6, 8 and 10 are substituted by a methyl group,

the positions 1 and 2 are substituted by a methylester group, the position 5 is substituted by a methyl group, the position 7 is substituted by an isopropyl group and the position 10 is substituted by a 4-methoxy styrene group or a styrene group,

the positions 1 and 2 are substituted by a methylester group, the positions 5, 6 and 10 are substituted by a methyl group and the position 8 is substituted by an isobutyl group,

the positions 1 and 2 are substituted by a methylester group, the positions 5 and 10 are substituted by a methyl group and the position 7 is substituted by an isopropyl group,

the position 1 is substituted by a methylester group, the position 2 is substituted by a carboxylic acid group or vice versa, and the positions 5, 6, 8 and 10 are substituted by a methyl group,

the position 1 is substituted by a methylester group, the position 2 is substituted by a carboxylic acid group or vice versa, the positions 5 and 10 are substituted by a methyl group and the position 7 is substituted by an isobutyl group,

the positions 1 and 3 are substituted by a methyl ester group, the position 7 is substituted by an isopropyl group and the positions 8 and 10 are substituted by a methyl group,

the position 1 is substituted by a methyl ester group, the position 2 is substituted by a $CH_3-(CH_2)_2-C_6H_{10}-(CH_2)-C_6H_{10}-COO-$ group and the positions 5, 6, 8 and 10 are substituted by a methyl group.

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~~said substituents C^1 and C^2 contains a π-electron system~~ which is in conjugation with the π-electron system of the heptalene core, and

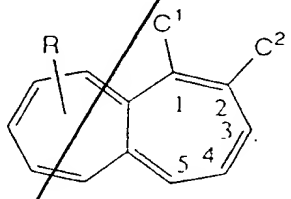
whereby said [4n]-heptalenes can comprise at least one further substituent R being selected from the above indicated groups with n being 0-8,

provided that if one of the at least one further substituents R is a isopropyl group at the position 9 of the heptalene ring, the substituent at the position 6 ~~must not be a methyl group~~.

~~18~~ 17. [4n]-heptalenes according to claim ~~17~~ 16, whereby, C^1 and C^2 represent independently from each other a hydrogen atom, a methyl group, a phenyl group, an ethyl ester group, a methyl ester group, a (E)-PhCH=CH group, a (E)-4-$MeOC_6H_4CH$=CH group, a (E)-4-ClC_6H_4CH=CH group, a 4-$MeOC_6H_4$ group, a -CH=CH-CH=CH-C_6H_5 group, a -CH=CH-$C_6H_4NO_2$-4 group, a -CH=CH-C_6H_4OMe-4 group, with the proviso that a heptalene substituted by a methylester group at the position 1, a -CH=CH-CH=CH-C_6H_5 group at the positions 2 and 5, an isopropyl group at the position 7 and a methyl group at the positions 4 and 8 is excluded.

~~19~~ 18 ~~20~~. [4n]-heptalenes according to claim ~~18~~ 16 or ~~19~~ 17, whereby said further substituents R are selected from the group comprising substituted or unsubstituted C_1-C_{18}-alkyl groups or photoactive diazo containing groups, like azobenzen.

~~20~~ 19. Method for the preparation of substituted heptalenes of the formula (I) or (II), ~~according to anyone of the claims~~ 16 ~~-18~~



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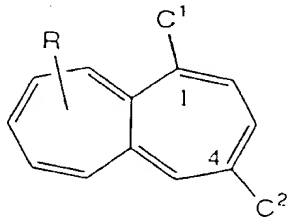

(II)

whereby C^1, C^2, R and n are as above defined, comprising the steps of

(a) obtaining a heptalene-dicarboxylate by a reaction of a correspondingly substituted azulene with acetylenedicarboxylate, and optionally

(b) transforming ~~said methyl~~ substituent, ~~at the position 1 of the heptalene ring~~, into the desired conjugated substituent having an extended π-electron system.

~~21~~ 20. Method according to claim ~~20~~ 19, whereby a heptalene-4,5-dicarboxylate carrying a methyl substituent at the position 1 of the heptalene ring is obtained.

~~22~~ 21. Method according to claim ~~20 or 21~~ 19, further comprising a step (c) wherein at least one of the carboxolate groups within the heptalene ring is replaced by a conjugated substituent containing an extended π-electron system.

~~23~~ 22. Method according to claim ~~22~~ 21, wherein the carboxylate group at the position 4 of the heptalene ring is replaced by a conjugated substituent containing an extended π-electron system.

~~24~~ 23. An optical storage device comprising at least one substituted [4n]-annulene according to ~~one of the~~ claims 17~~-19~~.

~~25~~ 24. A non-linear optical device comprising at least one substituted [4n]-annulene according to ~~one of the~~ claims ~~17-19~~ 16-18.

~~26~~ 25. Use of substituted [4n]-annulenes <1> undergoing thermally induced or photo-induced double-bond shifts (DBS) thus generating two different conjugation states with at least one substituent, for information storage and data processing.

<1> = which are substituted by at least one group comprising an extended conjugated π-electron system which is in conjugation with the π-electron system of the [4n]-annulene core